A New High Efficiency Segmented Thermoelectric Unicouple

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To achieve high thermal-to-electric energy conversion efficiency, it is desirable to operate thermoelectric generator devices over large temperature gradients and also to maximize the thermoelectric performance of the materials used to build the devices. However, no single thermoelectric material is suitable for use over a very wide range of temperatures (~300-1000K). It is therefore necessary to use different materials in each temperature range where they possess optimum performance. This can be achieved in two ways: 1) multistage thermoelectric generators where each stage operates over a fixed temperature difference and is electrically insulated but thermally in contact with the other stages 2) segmented generators where the p- and n-legs are formed of different segments joined in series. The concept of integrating new thermoelectric materials developed at the Jet Propulsion Laboratory (JPL) into a segmented thermoelectric generator has been presented in detail in earlier publications . This new generator is expected to operate over a 300-973 K temperature difference and will use novel segmented legs based on a combination of state-of-the-art thermoelectric materials and novel p-type Zn_4Sb_3, p-type $CeFe_4Sb_{12}$-based alloys and n-type $CoSb_3$-based alloys. An increase in the conversion efficiency of about 60% is expected compared to conventionnal Bi_2Te_3- and PbTe-based generators. We present in this paper the latest experimental results from the bonding studies between the different segments of the p-legs, n-legs, and p-leg to n-leg interconnect. Evaluation of the bond quality was done by measuring the contact resistance across the joints as well as by detailed microstructure investigations to reveal any potential interdiffusion. Among the materials investigated as inter-layers between the different segments of the legs, Pd-Ag joining alloys have been found to provide mechanically stable and low electrical resistance bonds.

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